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# The Correlation between Industrial Organization and Sustainable Growth of City Cluster Spatial: A Case Study of Harbin-Changchun City Cluster

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## Abstract

The Harbin-Changchun City Cluster (HCCC) is an important growth engine for the revitalization of the Northeast, and it is also the main mode and spatial platform for the implementation of the new urbanization of the country. Industrial functional organization, structural upgrading and spatial transfer are important driving force for the growth of City Cluster. According to the statistical data of the employed population and industrial output value, we study the industrial spatial layout features and structural evolution of the HCCC and then explore the correlation between industrial organization and the City Cluster spatial based on the Industrial Agglomeration Indicators Analysis and the Locational Gini Coefficient. At the macro level, it is found that the industrial structure and specialized division of labor affect the spatial network and the axis pattern of the City Cluster; at the meso level, the industrial quantity and spatial distribution affect the layout of key cities and node towns in the City Cluster; at the micro level, the industrial level and transformation and upgrading affect the changes of urban spatial structure and the optimal allocation of relevant land.

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**Keywords:** spatial sustainable growth, industrial organization, Harbin-Changchun City Cluster, industrial agglomeration, spatial structure evolution

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## 1. Research Questions and Objectives

### 1.1. Research Questions

In the process of industrialization and urbanization, City Clusters with overall competitive advantages will become main players participating in global competition and international division of labor in the future, since they are the most dynamic regional units and spatial organization forms in future economic development.

At present, the City Cluster has been regarded as the main mode of the country's urbanization drive. The HCCC is not only the new growth pole of the Northeast region but also the core carrier for the country to implement the regional coordinated development strategy of the eastern, central and western regions according to "National Plan on New Urbanization (2014-2020)" and a new round of National Strategy on revitalization of Northeast. However, there are many uncoordinated phenomena between the cities of the City Cluster industrially, which hinders its sustainable healthy development for the HCCC is still in the early stage and spans two provinces of Heilongjiang and Jilin [1] (Fig. 1.).

Any kind of industrial activity is associated with space. The closeness of the internal relation of the industrial structure is crucial to the formation and evolution of the regional spatial structure [2]. Some scholars believe that although the Northeast is a traditional industrial base in China which has gathered a large number of manufacturing enterprises that is the result of administrative orders under the planned economic system, rather than the industrial division of labor and collaboration. In the context of planned economic, the means of production and manufactured products are planned purchase and supply (by the state), thus the manufacturing enterprise only acts as a "workshop" in a certain sense. It only responsible for the manufacturing products, but not for the transportation and sales of upstream and downstream raw materials and products. That is why Northeast can still become a national industrial base though it is far away from the main raw material production and market hinterland. Therefore, the industrial cluster of the Northeast region in the planned economy period, in a strict sense, was not industrial cluster, it is only "product agglomeration" [3].



Fig.1 HCCC in China's position and administrative areas

Since the reform and opening up, the industrial system in Northeast China has shown "lag" in institutional changes though China's overall economic system has undergone a transition from planning economy to market economy. The institutional inertia has hindered the formation and development of industrial cluster of Northeast

China in the true sense [4]. Although a large number of enterprises are concentrated in the “comprehensive body” and its surrounding areas, specialization is low and enterprises are limited to do input-output business of different products. Therefore, industrial cluster and innovation in this “enterprise concentration area” can only bring negligible benefit. Nevertheless, whether it is “product agglomeration” or “enterprise concentration”, the industrial layout must interact with the regional spatial structure. It is manifested as follows: the growth of the number of enterprises, the development and improvement of the division of labor system, the expansion of industrial space and the formation and differentiation of the group of employees can have a direct impact on the economic and social space of City Cluster; on the other hand, the economic and social space of City Cluster provide conditions and space carriers for the formation and development of industrial agglomeration, and also promote or hinder the development of industrial agglomeration by the features of resources and location, the changes of spatial structure, network system, policies and environment [5]. Therefore, the research on industrial cluster is related to the interpretation of the spatial structure of City Cluster.

## 1.2. Research purposes

The development of China's City Cluster is uneven, and most of them are still immature. That is especially the case for those inter-provincial administrative regional City Clusters which often have difficulties in industrial cooperation and vary in development paths, thus hindering the sustainable growth of City Cluster space. This paper will start with the division of labor, divide the industry (focus on manufacturing) into different ways, and analyze the shape and change of its space, thus interpreting the spatial attributes of the industry and the relationship between the formation and evolution of the spatial structure of the HCCC.

The research purpose of the thesis mainly includes two aspects--interpretative and applied. (1) For interpretation purpose, this paper reveals the mechanism of the industrial organization's role in the spatial growth of the HCCC, that is, how the spatial attributes of industrial factors affect the formation and evolution of the spatial structure of the HCCC. (2) For application purpose, this paper objectively evaluates the changes in the social economy (especially industrial organization) of the HCCC and the changes in its regional spatial organization.

## 2. Research methods and data sources

### 2.1. Research methods

The analysis methods of existing industrial clusters mainly include Industrial Agglomeration Indicators Analysis, Input-Output Analysis, Principal Component Analysis, and Multivariate Cluster Analysis, Innovation Degree Analysis, etc. [6]. This chapter uses Industrial Agglomeration Indicators Analysis in consideration of the availability of data. In the choice of index, the most commonly used agglomeration metrics include the Herfindahl-Hirschman Index (H-HI), Location Quotient (LQ), and Geographic Concentration Coefficient (GCC), Locational Gini Coefficient (LGC), Ellison-Glaeser Coefficient (E-GC), and the like. By comparison, the study used the “Location Gini Coefficient (LGC)” proposed by Krugman. It is widely used since its calculation is simple and clear. Some studies have shown that LEG is more accurate than GCC and other indices in describing the imbalance of industrial layout in the region [7]. Although E-GC can overcome this defect to a considerable extent, but limited to data resources, this paper will focus on the LGC analysis, supplemented by spatial econometric analysis and qualitative judgment to compensate for the defect of it. The LGC is between 0-1, and the larger the coefficient, the higher the geographical concentration of the industry. The calculation formula of the LGC is as follows:

$$G = \sum_i (S_i - X_i)^2 \quad (1)$$

In this forum:

$S_i$ —represents the number of employee/output value of an industry in the region accounts for the proportion of the total employment/output value of the industry in the HCCC.

$X_i$ —The total number of employee/output value of the  $i$  region accounts for the proportion of the total number of employees/total output of the HCCC.

## 2.2. Data Selection and Source

In order to study the industrial cluster of the HCCC, the author collected data on the employees of the Heilongjiang Province and Jilin Province Economic Census Yearbooks in 2004, 2008 and 2013. Because of the large number of industries in the yearbook, the data were appropriately screened and merged in order to clearly reflect the characteristics of the industrial space.

This research selects the advantageous industries and related industries based on the location entropy of employees, and finally concludes four advantageous industry categories (Table 1.): equipment manufacturing, agricultural product processing and food and beverage manufacturing (hereinafter referred to as “agricultural products and food”), medicine industry, and chemical industry. Due to its particularity, the extraction industry is basically consistent with the mineral deposits, and has slightly difference at the prefecture-level city; while the output value of the construction industry, non-metallic mineral products industry account for a certain proportion in most cities in the Northeast. However, considering that it is mainly low-end building materials industry with relatively even distribution, there is no significant agglomeration. Therefore, these industries are not within the scope of this study.

Table 1. Advantages Industries and Related Industries of HCCC

Industry Sector	Industry Sub-sector
Equipment manufacturing	Metal products industry, general equipment manufacturing, special equipment manufacturing, transportation equipment manufacturing, electrical machinery and equipment manufacturing, computer, communication and other electronic equipment manufacturing, instrumentation and culture, office machinery manufacturing
Agricultural product processing, food and beverage manufacturing	Agricultural and sideline food processing industry, food manufacturing, beverage manufacturing
Medicine industry	Pharmaceutical manufacturing
Chemical industry	Petroleum processing and coking industry, chemical raw materials and chemical products manufacturing, chemical fiber manufacturing, rubber products, plastic products

## 3. Spatial Feature and Structural Evolution of Harbin-Changchun City Cluster

### 3.1. The General Characteristics of the Industrial Space of Harbin-Changchun City Cluster

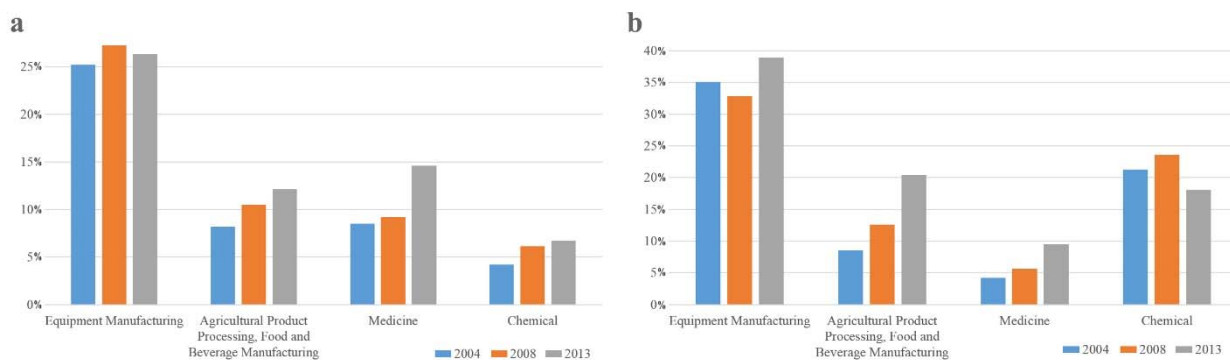


Fig.2 (a) Employment structure change of industries in HCCC; (b) Structural change of gross industrial output value in HCCC

In terms of employment structure of industries (Figure 2.a), among the four advantageous industries within Harbin-Changchun City Cluster, equipment manufacturing personnel occupy a dominant position, accounting for about 27% of total industrial personnel; medicine personnel occupy a small proportion of about 6%; personnel in other industries account for 8-15% or so. In 2004-2013, the proportion of personnel in other industries has increased,

especially in the agricultural and food industries except for a slight decline in equipment manufacturing industry. The proportion of equipment manufacturing industry also ranks first, about 30-40% according to structural change of gross industrial output value (Fig. 2. b). It is worth noting that the structure of gross industrial output value has undergone significant changes on the premise that little change occurred to the industrial employment structure. The proportion of output value of agricultural products, food, medicine, equipment manufacturing and other industries increased, while that of chemical industry decreased. This dedicates that in 2004-2013, (1) the per capita productivity of industries represented by the chemical industry declined; (2) the per capita productivity of industries represented by equipment manufacturing, agricultural products and food industries increased relatively.

### 3.2. SGC Changes of Industry in HCCC

By analyzing the SGC of different industries in Northeast China from 2004 to 2013 (Fig. 3), the results obtained show that: (1) in general, the industrial distribution in Northeast China is relatively dispersed, and the Gini Coefficient of the most concentrated chemical industry is merely 0.16. (2) Apart from equipment manufacturing, there is a trend of industrial agglomeration for most industrial categories between 2004 and 2008, while in 2008-2013 they tended to be decentralized, and the absolute value has limited change (within 0.1). According to the above analysis, several advantageous industries in Northeast China showed the "stickiness" of industrial space in 2004-2013, and the spatial concentration remained basically at the existing level, but the overall pattern was decentralized.

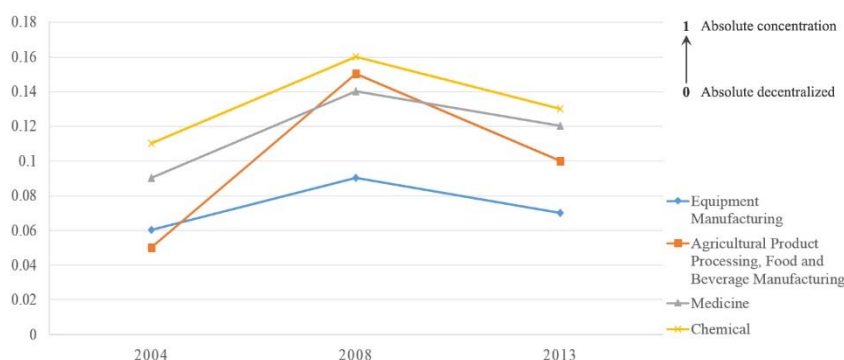


Fig.3 Analyzing the SGC of different industries in Northeast China from 2004 to 2013

### 3.3. The Structural Evolution of the Industrial Space of HCCC

According to the spatial distribution of four industry categories analyzed above, the spatial distribution of industries and the number of employees in the industry sub-sector category (Figure 4. Figure 5. Figure 6. Figure 7.), which is consistent with the analysis results of SGC is formed, that is, the main industrial categories are relatively scattered in space, and no distinctive industrial division exists between cities. As for Harbin and Changchun two core cities, their industrial structure in "urban-regional level" is mature and comprehensive, most industrial spaces have formed the "core city and provincial sub-central city" industrial agglomeration gradient except some chemical industries strongly dependent on the origin of raw materials. The reasons for the above phenomena are: (1) the original industrial base of these areas is relatively good; (2) due to the "stickiness" and "lock-in effect" of industrial space selection, there is no clear industrial division of labor between the central city and the hinterland; (3) there are no significant differences between entry barriers such as the policy restrictions and costs of the central city and hinterland industries.

Therefore, in terms of overall spatial structure, both existing industrial expanding and new industry entry tend to be placed in central cities and regions with more resources. Industrial cluster takes on a strong "location sticky" and "circulative accumulation" effect [8].

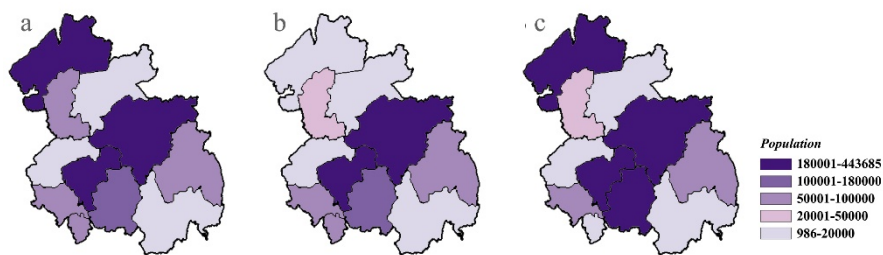


Fig.4 The spatial distribution of the employees of equipment manufacturing in HCCC

(a) In 2004; (b) In 2008; (c) In 2013

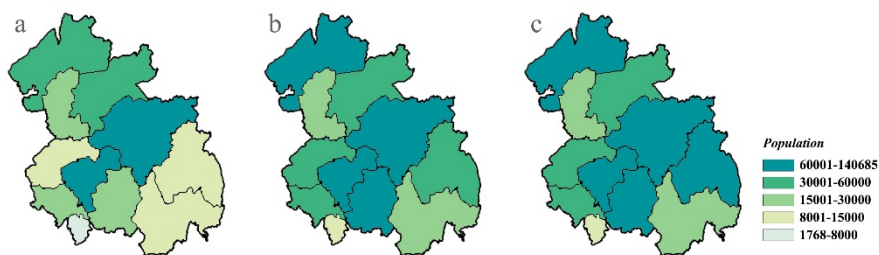


Fig.5 The spatial distribution of the employees of agricultural products and food manufacturing in HCCC

(a) In 2004; (b) In 2008; (c) In 2013

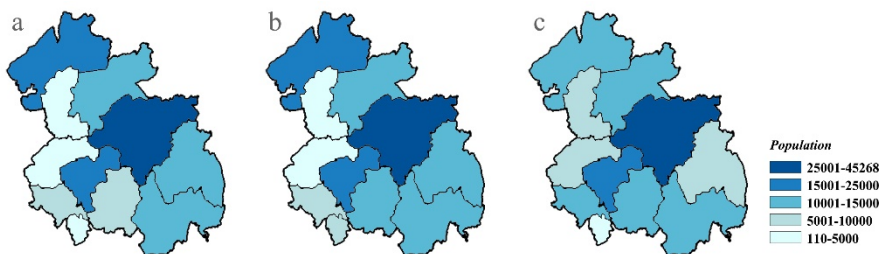


Fig.6 The spatial distribution of the employees of medicine industry in HCCC

(a) In 2004; (b) In 2008; (c) In 2013

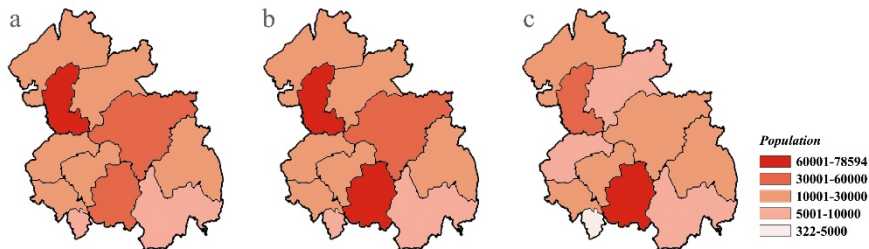


Fig.7 The spatial distribution of the employees of chemical industry in HCCC

(a) In 2004; (b) In 2008; (c) In 2013

The layout characteristics of this advantageous industry have widened the gap between the core areas of the region and the marginal areas, and the spatial structure featuring “core-edge” has been continuously circulated and

strengthened. As for specific spatial distribution, various industry categories represent certain similarities, that is, most of the dominant industries are concentrated in the arch bulge region ranging from Changchun to Harbin and Qiqihar. This feature has the most complete performance in the spatial layout of equipment manufacturing as well as agricultural products and food industry.

#### **4. Correlation Analysis Between Industrial Organization and Spatial Structure of City Cluster**

Over the past decade, Harbin-Changchun City Cluster has undergone spatial restructuring and achieved diversity development; but most cities and towns in Harbin-Changchun City Cluster has a relatively loose connection as well as slow progress in economic and industrial agglomeration when compared with Beijing-Tianjin-Hebei, Yangtze River Delta, Zhujiang River Delta and other regions with more mature urban system [9]. Northeast China has gradually evolved from a relatively homogeneous regional hierarchy of "Harbin-Changchun-municipal districts-county level city" to the overall spatial pattern that municipal districts such as Harbin and Changchun work as core cities, together with such "cities-regions" as Changchun, Jilin, Harbin, Daqing and Qiqihar constitute the development highland, which build the "core to periphery" nested spatial structure at different dimensions.

##### *4.1. Harbin and Changchun as the Core of the City Cluster*

As regional central cities, Harbin and Changchun have been proved by many associated researches. The analysis of this study shows that the economic activities of Harbin and Changchun are highly concentrated in the municipal district, reflecting its characteristics of high concentration. In terms of economic development in surrounding areas, the correlation between Changchun and Harbin is "high-low dispersion", which means the core municipal districts develop as an isolated island with the tendency of industrial agglomeration and have built a large development gap with neighboring counties and cities, which is related to the comprehensive competitiveness of the city. In general, Harbin and Changchun still have some differences as the core of regional development.

##### *4.2. The "Low Valley Area" in the Main Axis of City Cluster Development*

The results of the analysis show that Harbin-Changchun has become the regional development axis of the Northeast China and its advantages would be maintained for a long time. However, the inter-provincial junction is a relatively "low valley area" on the development axis. It can be seen that the influence of "province" the administrative boundary imposes more obvious hinder to the development of City Cluster. The Harbin-Changchun development axis has cracks; a more accurate description is that provinces radiate outwards centered on the core city, forming a development highland featuring uncontinuous block-like series.

##### *4.3. The Gradual Reorganization of Economic Space Within the City*

Compared with the township, county and city economies in the developed coastal areas of the southeast, the economic and social activities of the Harbin-Changchun City Cluster are highly concentrated in municipal districts, while the county economy is underdeveloped; the incomplete development of small and medium-sized cities and towns in the urban system is a long-term development feature of the Northeast region [10]. Although the GDP of some prefecture-level cities and districts has decreased compared with that in 2004, among the 11 prefecture-level cities in the HCCC in 2017, there were still nearly two-thirds of the municipal districts whose GDP accounted for over 40% of the whole city. Therefore, under the prefecture-level city scale in Northeast China, there is a pattern in which the municipal district is the core and the other counties and county-level cities are semi-marginal or marginal regions. It can be seen by analyzing the manufacturing industry and other related industries that the cities in the HCCC experienced the reorganization process of municipal industry space in which manufacturing industry spread to the periphery of the municipal area, while the productive services industry flooded to the highly concentrated municipal areas.



#### 4.4. Sluggish Development in Marginal Areas

What makes stark contrast to the towns and several prefecture-level municipal districts on the City Cluster development axis is the weak growth of the general counties and cities as well as the sluggish overall development. As such counties and cities have neither regional advantages nor policy concerns, they are gradually marginalized whether in terms of the ability to absorb industries and resources or the level of economic and social development and the speed of development. As a result, there is a widening gap between the towns located in general counties in marginal areas and other towns.

Based on the above analysis, on the macro scale of the Harbin-Changchun City Cluster, the regional structure that the Harbin-Changchun serve as the axis, the core regions are relatively prosperous, and marginal regions are slacken off. The relatively prosperous core areas are comprised of such cities as Changchun, Jilin, and Tumen in Jilin Province as well as those core cities in the southern part of Heilongjiang. On the meso scale from “city-region”, Harbin and Changchun as the core cities play an organizational function in their “city-region”, which is strong in the agglomeration but weak in driving the development of surrounding areas. On the microscopic scale of the city, due to its own development trajectory characteristics, the large and medium-sized cities of the Harbin-Changchun City Cluster often take the municipal jurisdiction as the core, and there is a big gap between the development level of other counties and cities within the city area, presenting that the city is undergoing such “isolated island development.”

### 5. Conclusions and Prospects

At the macro level, the natural location conditions, economic development stages, and industrial structure of the cities in the Harbin-Changchun City Cluster determine that these cities have different functions in their city cluster, and the division of labor and specialization are the source of economic growth for the Harbin-Changchun City Cluster. Each city undertakes relevant functions in the city cluster according to its comparative advantages, and cooperation and exchanges between cities within the Harbin-Changchun City Cluster have been enhanced by deepening of the division of labor, reducing production and transaction costs. Therefore, the industrial structure and specialized division of labor have an impact on the spatial network and axis pattern of city cluster. The coordinated development model of Harbin-Changchun City Cluster featuring “dual-core synergy and development in the shape of Chinese character ‘#’” is a kind of supplement and innovation for the spatial distribution landscape of city cluster with “dual-core, one-axis and two-belt”.

At the meso level, the spatial connection of industry is the root of the interaction between the nodes of the Harbin-Changchun City Cluster. The alternative combination of agglomeration and diffusion promotes the spatial organization structure of city cluster to evolve. The industrial quantity and spatial distribution work as fundamental mechanism to form and optimize the spatial structure of Harbin-Changchun City Cluster, in which different levels of cities are formed in the original homogeneous space, then the hierarchical structure and urban system of the city cluster took shape. Therefore, the concentration and diffusion force are important driving forces for the spatial evolution of Harbin-Changchun City Cluster, and the industrial quantity and spatial distribution affect the layout of key cities and node towns in the city cluster.

At the micro level, industrial upgrading is the internal driving force for promoting urban spatial organization structure. The city accelerates the withdrawal of declining industries and the development of new industries by upgrading the industrial level as well as the industrial transformation, brings about changes in internal industrial structure, and promotes the evolution of urban spatial structure. The industrial output of the former urban fringe areas has increased substantially, and the economic links between the former urban fringe areas and the urban center have become closer and closer, gradually promoting the extension of the city and the growth of the nuclear. Therefore, industrial level, transformation and upgrading influence the changes of urban spatial structure and the optimal allocation of land use.

The sustainable growth of city cluster space is the result of nesting and co-construction of economic, social, political and other various relationships and their spatial attributes thereof. However, what this paper has studied is limited to the analysis of industrial organization, hence it is difficult to explain the evolutionary mechanism of the spatial structure of Harbin-Changchun City Cluster in a comprehensive and rigorous way. Further expansion of the



research framework, introduction of other factors that affect the spatial evolution of City Clusters, and implementation of necessary empirical analysis are issues that wait to be resolved in future research.

## 6. Acknowledgements

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## References

- [1] National Development and Reform Commission. "Plans for the development of Harbin-Changchun City Cluster." *China's State Council* (2016).
- [2] Smith, R. G. "Beyond the Global City Concept and the Myth of 'Command and Control'." *International Journal of Urban and Regional Research* 38(1) (2014): 98-115
- [3] Wu Yuehua. "Industrial agglomeration: the predicament and outlet of the old industrial base in northeast China: from the perspective of new economic geography." *Contemporary Economic Research* (01) (2007):38-41.
- [4] Cheng Yao; Zhao Min. "Analysis and Prospect on the Development of 'Global Cities' In China: From the Perspective of Spatial Organization Models." *City Planning Review* 39(02) (2015): 9-15+22.
- [5] Zhang yunfei. "Empirical Studies on the Relationship between Industrial Agglomeration and Economic Growth within the Urban Agglomeration: Based on Panel Data Analysis." *Economic Geography* 34(01) (2014):108-113.
- [6] Li Chunjuan, You Zhenlai. "Industrial Cluster Identification Methods and Evaluation." *Urban Problems* (12) (2008): 29-33.
- [7] Spiezia, V. "Measuring regional economies in owed countries, In: Organization for Economic Cooperation and Development, OECD. Income Disparities in China: An OECD Perspective Development, O.E.C.O. and Economy, C.G.D.N. and Non-members." *OECD Publishing* (2004):181-198
- [8] He Xionglang, Zheng Changde, Yang Xia. "Theoretical and Empirical Analysis of Spatial Correlation and Dynamic Convergence of Regional Economic Growth in China: Evidence from the Panel Data from 1953 to 2010." *Journal of Finance and Economics* 39(07) (2013): 82-95.
- [9] Wang Shifu, Liu Zheng, Zhao Miaoxi, Deng Zhaohua. "A Research on Regional Disparity in Guangdong (2000-2010)." *Urban Planning Forum* (02) (2014): 32-39.
- [10] Liu yanjun, Li chenggu, Sun di. "Nurture the Industrial Pillar System of Cities system development in Northeast Area." *Northeast Asia Forum* (02) (2007):74-78.